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Iberica.—What the *Scientific American* is for the American, *Cosmos* for the Frenchman, *Nature* for the Englishman, that is *Iberica* for the Spaniard. The necessity of a weekly scientific magazine, well illustrated and with up-to-date articles was long felt by Spanish-speaking people. That *Iberica* supplies this need is plainly shown by the fact that two months after its appearance the copies of *Iberica* were spread all over the provinces of Spain and the different South American republics. I have seen *Iberica* on the shelves of the great libraries of Boston, New York and San Francisco, as well as in the private libraries of distinguished scientific men of this country.

MT. HAMILTON, January 20, 1915.

PERIODIC VARIATION IN THE POSITION OF THE MIRE IN 1914.

BY R. H. TUCKER.

The position of the Mire with reference to the true meridian has been derived from the meridian-circle observations of the past year. Evidence of change in its position was apparent in the current reductions for clock errors, made usually once a week, and at the close of the year the definite computations of the azimuth furnish material for the complete comparison of positions.

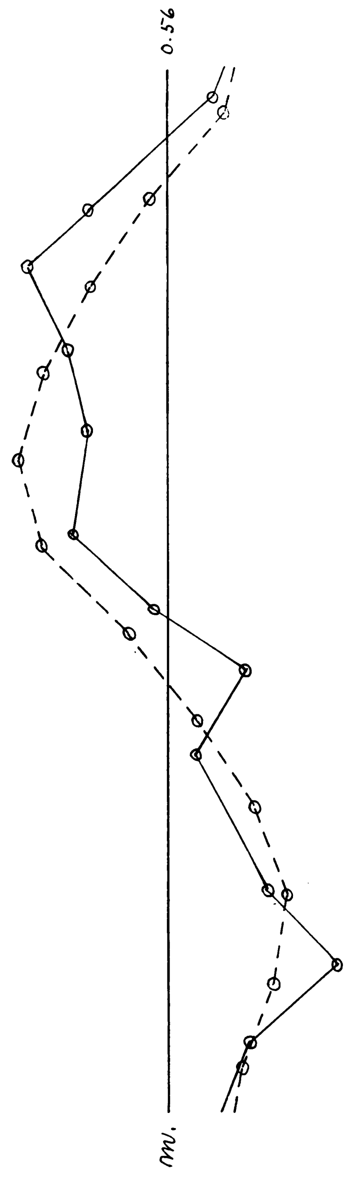
It is necessary to consider all the sources of possible systematic error, in order that these shall be eliminated from the results. Systematic errors in the right ascensions of the circumpolar stars, employed for the determination of the azimuth of the meridian circle, might be suspected of producing apparent periodic changes in the position of the Mire. A very complete discussion of the determinations of the Mire was published in the *Lick Observatory Bulletin,* No. 213, in the year 1912. That discussion was based, primarily, on the observations of *Polaris,* during the fundamental work of the years 1905 to 1908, and the results were accordingly unaffected by systematic errors of right ascension. The results of the meridian-circle observations, previous to the beginning of the fundamental work, were also tabulated, as well as the general trend of the changes up to the year 1912. The fundamental work showed a distinct annual periodic term, a daily periodic term, and a secular change which seemed to have been continuous from 1904 to 1912. The observations of the eleven years, from 1893 to 1904, gave a well-determined annual term of the form, $-0^{s}.060 \sin \Delta\alpha$, where $\Delta\alpha$ was reckoned from the first of December; and the application of this term reduced the average residuals per month from $0^{s}.029$ to $0^{s}.006$, which is distinct evidence of the faithfulness of the term in reproducing the variation. Since 1912 the secular change appears to have ceased, and there was only slight indication of such change previous to 1904. In those eight years, the total amount was nearly $0^{s}.4$ or about $6''$. At the distance of the meridian mark from the instrument, a change of $2''$ corresponds to about a hundredth of an inch. The tiny hole in the metal disc, which gives an illuminated circle for the meridian mark, lies to the west of true south, and is about $12''$ in diameter. The movement is toward the east in winter, reaching a minimum distance in March and a maximum in late summer. In the discussion of its position, given in the published *Bulletin*, the systematic observations of *Polaris*, and the continued series of the early night observations unite in confirming the annual term, while the daily periodic term is only evident in the observations of *Polaris*, which were made at every hour of the day and night. In the present series for 1914, the determinations were generally included between 8 P. M. and midnight, tho some were made an hour or two outside these limits.

The following tabulation of ΔM is made up by combining the means of eight consecutive nights, which constitute a program containing the same fundamental stars, with the monthly means. The programs give somewhat unequal distribution in the year, owing to the bad weather of January, April and December, while the monthly means have considerable variety of weights, from April with two nights, to July and November with thirteen each. The combination gives a better distribution of the same material. The values tabulated, with the respective dates, have been plotted, to give a graphical illustration of the periodic variation. The values have not been smoothed out into curves; but the more regular one, in broken lines, can be easily distinguished as that of the periodic term from eleven years.

Date	Mean ΔM	Reduced ΔM	v.
Jan. 25	0^s.521	0^s.569	+^{s}.012
Feb. 21	.481	.540	—.017
Mar. 17	.513	.570	+.013
May 3	.546	.573	+.016
June 1	.522	.522	—.035
June 23	.565	.542	—.015
July 20	.601	.555	—.002
Aug. 27	.596	.536	—.021
Sept. 24	.605	.550	—.007
Oct. 23	.623	.587	+.030
Nov. 11	.597	.578	+.021
Dec. 21	.539	.559	+.002
Mean.	—0^s.559	0^s.557	
v.	± 0 .039		± 0^s.016

The probable errors of determination give some indication of the real nature of the variation. The determination of the position of the Mire is practically free from any effect depending upon instrumental errors, and variations of these errors. The azimuth has been determined from two pairs of circumpolar stars each night, near the beginning and the close of observations, with an interval of approximately three hours; and the reading on the Mire has usually been taken very close to the epoch of each pair of circumpolars. The change in the position of the Mire each night can then be compared with the change in the azimuth of the instrument, and in general these changes confirm each other, allowing for errors of observation.

The probable error of a single determination of the Mire is quite exactly ∓ 0^s.010, as found from the comparison of the two values of each night. This includes the error of reading on the Mire, and the error of azimuth from the two pairs of circumpolar stars; and the effect of changes in the position of Mire and instrument augments this probable error, when the changes do not agree in direction and amount.



Plot of ΔM, 1914; and Eleven-Year Annual Periodic Term.

The azimuth is the noticeably variable correction to the meridian-circle observations. It has been found to have a range in the past year of $0^s.63$, which is $9''.5$. On three quarters of the nights of this period, the progressive variation is large enuf to include a rate of change in the azimuth correction, at least $0^s.02$ in the three hours. The changes from day to day in the azimuth correction do not appear to follow any law, and those between adjoining dates of observation are often comparatively large. The direction of the change is more often negative than positive, for the hours employed in this series, in the proportion of two to one; while of the changes in excess of $0^s.02$, the proportion of negative to positive is three to one. This is an indication of a daily term in the variation of the azimuth of the instrument. The change during a night does not give any indication of the value found for the night succeeding, and there is no evidence of progressive changes in azimuth.

To follow up the probable error results, from the combination of values of ΔM in groups of four nights, when the same pairs of circumpolar stars were used, and the instrument was in the same position, the p. e. of a single night is found to be $\pm\ 0^s.018$. This is double the value which would result from accidental error of observation, and is thus an indication that the position of the Mire changes from night to night.

As a further check upon systematic errors due to the right ascensions of the circumpolar stars, if the probable error of a group of four nights is determined from the comparison of sets of four nights clamp east and four nights clamp west, with the same pairs of circumpolars, this is found to be $\pm\ 0^s.027$. Taking successive groups of four nights in the same position of the instrument, but with different pairs of circumpolar stars, with approximately two hours' interval between, the probable error of a group of four is $\pm\ 0^s.015$. This is not only an indication that the systematic errors of right ascension are not of importance, but would seem to indicate that some residual error is due to the reversal of position, possibly to error in the adopted values of the collimation. The size of the probable errors of the groups, when compared with those of single nights, also indicates change in the position of the meridian mark. The probable error of a group of four nights, derived from a mean value of the meridian mark for the year, is ± $0^s.037$, which indicates again the existence of changes in position, aside from the errors of determination.

If we adopt the periodic term in the change of position, given by the eleven-year period, 1893 to 1904, the probable error of a group of four is reduced to ± $0^s.024$, two thirds of the p. e. without the application of the periodic term correction.

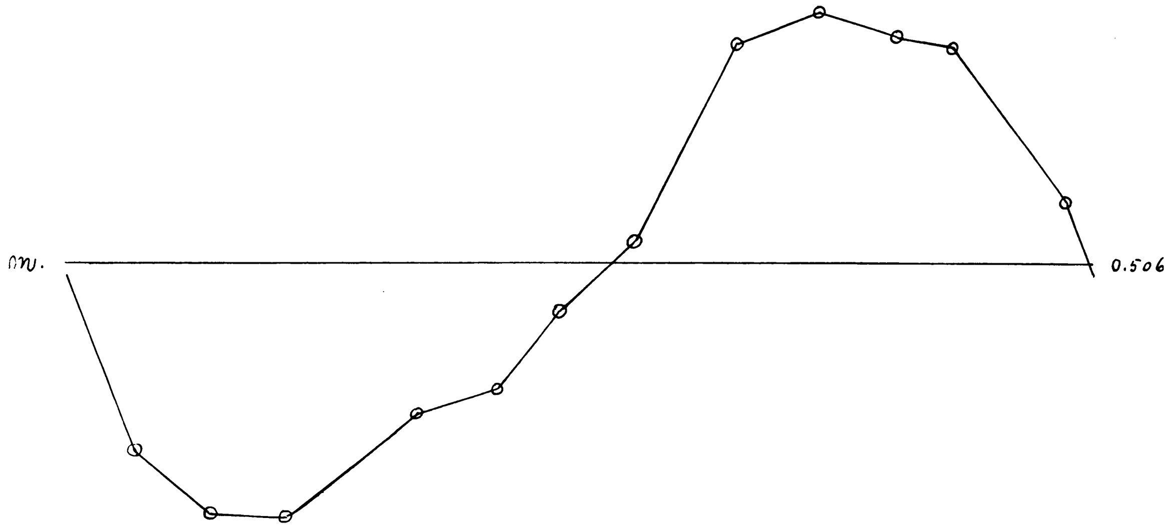
In the plot of the different determinations of the Mire position, the curve approximates very closely the sine curve given by the expression derived from the eleven-year continuous period. It would not follow a temperature curve for the year, since the maximum and minimum points occur near the equinoxes. The total range of ΔM is $3''.6$, from the extreme daily measures; the groups of four nights give a range of $3''.0$; while the programs of eight nights, averaging a month each, have a range of $2''.0$, equivalent to one hundredth of an inch. The formula for the periodic variation of the monthly values has an amplitude of $0^s.12$, or $1''.8$.

In the probable error tests of the original results, the fact that the computed probable error is much smaller than the average of the residuals indicates that these latter do not follow the law of accidental error, they being actually nearly uniform in size, with none exceeding twice the average. In the discussion of the values corrected for periodic variation, the individual residuals conform better to the law of accidental error, and single residuals equal three times the probable error, while the relation between average residual and probable error is closely that given by the theory of accidental errors. Tests by probable error can easily be misinterpreted, and conclusions in regard to the precision of observations can be drawn that are far from valid; but the proper use of the tests can often give us direct testimony of the existence of systematic error, and of the actual precision of results. The small size of the accidental error of determination of the position of the Mire from observations of different pairs of circumpolar stars on the same night, and the fact that errors of groups, with different pairs, are smaller than the errors of groups derived from the same pairs including reversal of the instrument, all tend to disprove the effect of any serious systematic errors in the right ascensions of the circumpolar stars used for azimuth.

The effect of the collimation correction needs to be considered. This has been larger during the past year than usual. But the average values of ΔM from the two positions of the instrument are exactly the same, with the same weight for each. There are twenty-four determinations of the collimation, made generally at reversal of the instrument, by the use of both collimators. The mean value of c is the same in each position, $+ 0^s.023$ clamp west, and $- 0^s.023$ clamp east. There would thus be a maximum mean effect of $0^s.046$, nearly $7''$, between determinations of ΔM in the two positions of the meridian circle. If the collimation should be assumed to be constant during the entire year, the probable error of a single determination of c would be $\pm 0^s.012$. But the variations were evident, and in general a value of the correction was adopted from the mean of two successive measures. The adopted values range from $0^s.000$ to $0^s.042$. If the collimation is assumed to be the same in the two positions, before and after reversal, the probable error of a single determination of c is $\pm 0^s.006$. No dependence upon temperature can be traced in the measures of collimation, the range of determinations being 44° to 82° Fahrenheit.

There remains the level correction to be considered. This has been found to vary but very slightly during a night, and to have but small changes between successive nights. There has been, however, during the past year, a well-defined curve of variation, which can be expressed in the form, $- 0^s.12 \sin \Delta t$, where Δt is reckoned from the first of January. The east end of the axis rises in late winter, and then falls to its lowest point thru spring and summer, to rise again in the late autumn. As this curve has maximum and minimum at points near the equinoxes, it does not correspond to a sine curve of annual temperature, tho this might be accounted for by a lag in the variation of the instrumental level.

The level correction has been tabulated here, in precisely the same manner as in the tabulation of ΔM preceding. The reduced values of the correction are obtained by the application



Plot of Level Variation in 1914.

of corrections for the periodic term, $-0^s.12 \sin \Delta t$, which is derived from the observations of this year. It will be remembered that the periodic term of ΔM was derived from observations made in the years 1893 to 1904, and applied to the observations of the current year:—

Mean Date	b	Reduced b	v.
Jan. 25	$-0^s.592$	$-0^s.543$	$-0^s.033$
Feb. 21	.621	.527	—.017
Mar. 17	.625	.508	+.002
May 3	.575	.472	+.038
June 1	.564	.506	+.004
June 23	.528	.514	—.004
July 20	.496	.537	—.027
Aug. 27	.403	.504	+.006
Sept. 24	.389	.508	+.002
Oct. 22	.400	.512	—.002
Nov. 11	.404	.494	+.016
Dec. 21	.477	.500	+.010
Mean.	$-0^s.506$	$-0^s.510$	
v.	± 0.078		$\pm 0^s.013$

In the mean values, April is not represented, and June has two values, as in the combinations of ΔM.

The probable error of a level determination, assuming that the level remains constant during the period of observation for every night, is found to be $\pm 0^s.006$. In the groups of four nights the probable error of a single night is $\pm 0^s.012$, indicating slight changes of level from night to night.

The total range of level correction is $0^s.33$, but the means of eight nights in a program have a range of $0^s.24$, or $3''.6$, the same amount as the amplitude of the computed periodic variation. A constant level correction has been adopted on each night.

The average difference between successive groups of four nights, in the two opposite positions of the meridian circle, is rather larger than the average difference between successive groups in the same position, indicating that some small part of the change in the level correction may be due to changed conditions at reversal, or to residual errors in the determination of the collimation correction.

To recapitulate: it must be plainly stated that the position of the Mire is referred to the true meridian, and it is determined independently of the actual changes in the meridian circle itself, except for the effect of such residual errors as may exist in the determination of the instrumental corrections. The observed range in the position of the Mire amounts to $0^s.24$, in the daily values. The monthly averages cover about half that range, and are well represented by a periodic sine term of the corresponding amplitude. The collimation correction of $0^s.023$, on the average, does not affect the determination, as the same mean value of the meridian mark is derived in both positions of the instrument. The level correction changes slowly, and has, during the year, a periodic variation expressed by a sine term of $0^s.24$ amplitude.

Confirmatory evidence of the freedom from the effect of any systematic errors in the right ascensions of the circumpolar stars is strong. If the periodic changes in the position of the meridian mark are due to a twist in the mountain, this might be expected to show in the azimuths of the meridian circle; but if so, the changes of azimuth are masked by the accidental variations, which are comparatively large. No material is here available for the discussion of a daily period. The secular change, which was plainly evident from 1904 to 1912, has ceased, and the mean values of the last three years have been approximately the same.

The similarity of the curves which represent the changes in the position of the meridian mark, and the change in the level of the instrument, during the year, must be evident. The same cause may operate in both cases, producing effects which are not dependent upon each other. A twist in the mountain, operating thru the year, may be accompanied by a tilt at the summit, which would be reproduced in a corresponding change in the level of the piers of the meridian circle. The reduction in the size of the average residuals is evidence of the real nature of the variation in both cases.

In this discussion one hundred nights of observation have been included, extending into January, 1915, with two nights.

The Mire can always be used as a check upon the azimuth, during short periods of time; and it is always useful for the necessary check upon computations. Many of the corrections to the instrument, which enter as corrections to the original results of observation, are largely eliminated in the computed places of the stars, since the right ascensions of the fundamental stars are adopted as standard, but the discussion of every source of error has its real value.

LICK OBSERVATORY, January 20, 1915.

PLANETARY PHENOMENA FOR MARCH AND APRIL, 1915.

BY MALCOLM MCNEILL.

PHASES OF THE MOON, PACIFIC TIME.

Full Moon	Mar. 1, 10^{h} 33^{m} A.M.		Last Quarter	Apr. 6, 12^{h} 12^{m} P.M.
Last Quarter	" 8, 4 28 A.M.		New Moon	" 14, 3 36 A.M.
New Moon	" 15, 11 42 A.M.		First Quarter	" 22, 7 39 A.M.
First Quarter	" 23, 2 48 P.M.		Full Moon	" 29, 6 19 A.M.
Full Moon	" 30, 9 38 P.M.			

The Vernal Equinox, the time when the Sun crosses the celestial equator from south to north and enters the sign (not the constellation) *Aries*, occurs on March 21st about 9 A. M. Pacific time.

Five of the planets, *Mercury, Venus, Mars, Jupiter* and *Uranus* are morning objects, but not all are far enuf away from the Sun for naked-eye observation. Their motions are apparently quite complicated.

Mercury passed inferior conjunction with the Sun on February 21st, and by March 1st rises not quite an hour before sunrise. Its apparent distance from the Sun increases until the morning of March 20th, when it reaches greatest west elongation 27° 44′. It then rises a little more than an hour before sunrise. The distance from the Sun then begins to grow smaller so that by the end of the month the interval between the rising of the Sun and of the planet is somewhat less than an hour. The interval during April grows continuously smaller, and superior conjunction is reached on May 1st. Thus the